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TRADITIONAL EMMER PROCESSING IN HIGHLAND ETHIOPIA

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ABSTRACT.—The cultivation of emmer wheat has all but disappeared in the modern world. The northern highlands of Ethiopia represent one of the few remaining regions where this cereal continues to be grown for human consumption. We present the results of an ethnoarchaeological study of non-mechanized emmer processing technology documented in south-central Tigrai, Ethiopia, focussing on small-scale household production. Despite high processing costs, land and water shortages, and the availability of more productive wheat species, the cultivation of emmer has persisted in highland Ethiopia. The results of this study draw attention to the role of women and shared labor in the household processing of hulled wheats and intercropped cereals. Processing techniques observed in Tigrai are compared to experimental studies, ethnoarchaeological, and historical sources on emmer processing, and implications for interpretations of the archaeological record are discussed.

Key words: Tigrai, ethnoarchaeology, intercropping, *Triticum dicoccum*, emmer processing, women in agricultural production.

RESUMEN.—El cultivo de escanda o trigo *emmer (Triticum dicoccum)* ha desaparecido prácticamente en el mundo moderno. Las tierras altas del norte de Etiopía son una de las pocas regiones que quedan donde este cereal aún se cultiva para el consumo humano. Se presentan los resultados de un estudio etnoarqueológico sobre la tecnología de procesado no mecanizado de la escanda documentada en el centro-sur de Tigrai, en Etiopía, centrado en la producción doméstica a pequeña escala. A pesar de los altos costes de procesado, la escasez de terreno y agua, y la posibilidad de acceso a variedades de trigo más productivas, el cultivo de escanda ha subsistido en las tierras altas de Etiopía. Los resultados de este estudio llaman la atención sobre el papel de las mujeres y el trabajo compartido en el procesado doméstico de los trigos con cáscara y los cultivos mixtos de cereales. Las técnicas de procesado observadas en Tigrai se comparan con estudios experimentales y fuentes etnoarqueológicas e históricas sobre el procesado de la escanda, y se discuten algunas implicaciones para la interpretación de los restos arqueológicos.

RÉSUMÉ.—La culture du blé amidonnier a pratiquement disparu du monde moderne. Les hauts plateaux du nord de l' Éthiopie représentent une des dernières régions où cette céréale est encore cultivée à des fins de consommation humaine. Dans cet article, les auteurs présentent les résultats d'une étude ethnoarchéologique menée dans le centre-sud de la région de Tigré, en Éthiopie. Cette étude documente les techniques de traitement non-mécanisé du blé amidonnier, et porte principalement sur l'unité de production à petite échelle des ménages. Malgré les coûts de transformation élevés, le manque de terres et d'eau, et la disponibilité d'espèces de blé à meilleurs rendements, la culture du blé amidonnier continue dans les hauts plateaux éthiopiens. Les résultats présentés dans cet article attirent l'attention sur le rôle des femmes et le partage des tâches dans le traitement des blés décortiqués et des céréales intercalaires à l'échelle des ménages. Les observations effectuées dans la région de Tigré sont comparées à des études expérimentales, ethnoarchéologiques et à des sources historiques documentant les techniques de transformation du blé amidonnier. Finalement, les auteurs examinent les implications d'une telle étude pour l'interprétation des données archéologiques.

INTRODUCTION

Emmer wheat (*Triticum turgidum* ssp. *dicoccum* (Schrank) Thell.) was a cereal integral to life in the ancient world. From its early beginnings during the mid-eighth millennium B.C., emmer quickly grew to dominate wheat production in the Near East, subsequently spreading to Europe, the Transcaucasus and eventually to the Indian subcontinent. Hulled wheats[1] such as emmer were eclipsed by free-threshing forms during the Near Eastern Bronze Age, early in the fourth millennium B.C. (Zohary and Hopf 2000:46–51), and never regained their early prominence. A minor crop grown today in isolated regions more commonly for animal than human consumption (Gunda 1983; Nesbitt and Samuel 1996:41–47), emmer is now mainly of interest to scientists concerned with conservation of agrobiodiversity (Negassa 1986; Nesbitt et al. 1996:234). Not surprisingly, it is of considerable significance to archaeobotanists conducting studies of ancient subsistence, and has been the focus of several investigations relating to processing technology, especially the dehusking of emmer spikelets[2] (Hillman 1984a, 1984b; Nesbitt and Samuel 1996; Samuel 1993, 2000). The first systematic field studies of hulled wheat processing were conducted by Hillman (1973, 1981, 1984a, 1984b), while detailed experimental replications have since been completed (e.g., Meurers-Balke and Lüning 1992, 1999; Samuel 1993). A comprehensive review of experimental and archaeobotanical research on hulled wheats is provided by Nesbitt and Samuel (1996:45–54), who emphasize the need for further ethnoarchaeological investigation to focus on dehusking and the role of parching. Although experimental replications and examination of ancient texts and reliefs have produced useful insights into these practices (e.g., Bower 1992; Meurers-Balke and Lüning 1999; Murray 2000; Samuel 1993, 2000), ethnoarchaeological studies of emmer production embedded in a living tradition have the potential to reveal more in the way of technological and social issues relating to the processing of this cereal.

The link between food processing/cooking and women's labor has been demonstrated in cross-cultural ethnographic studies (Kurz 1987; Murdock and Provost 1973). In particular the association between women and the processing of plant products is rather striking (Crown 2000:222–225; Kurz 1987:45; Watson and Kennedy 1991:255–259). Although both men and women share the burden of crop production and processing overall, in non-mechanized societies the latter stages (fine sieving, hand-sorting, pounding, and grinding) tend to fall predominantly in the domain of women. Interestingly, many of the products and by-products of

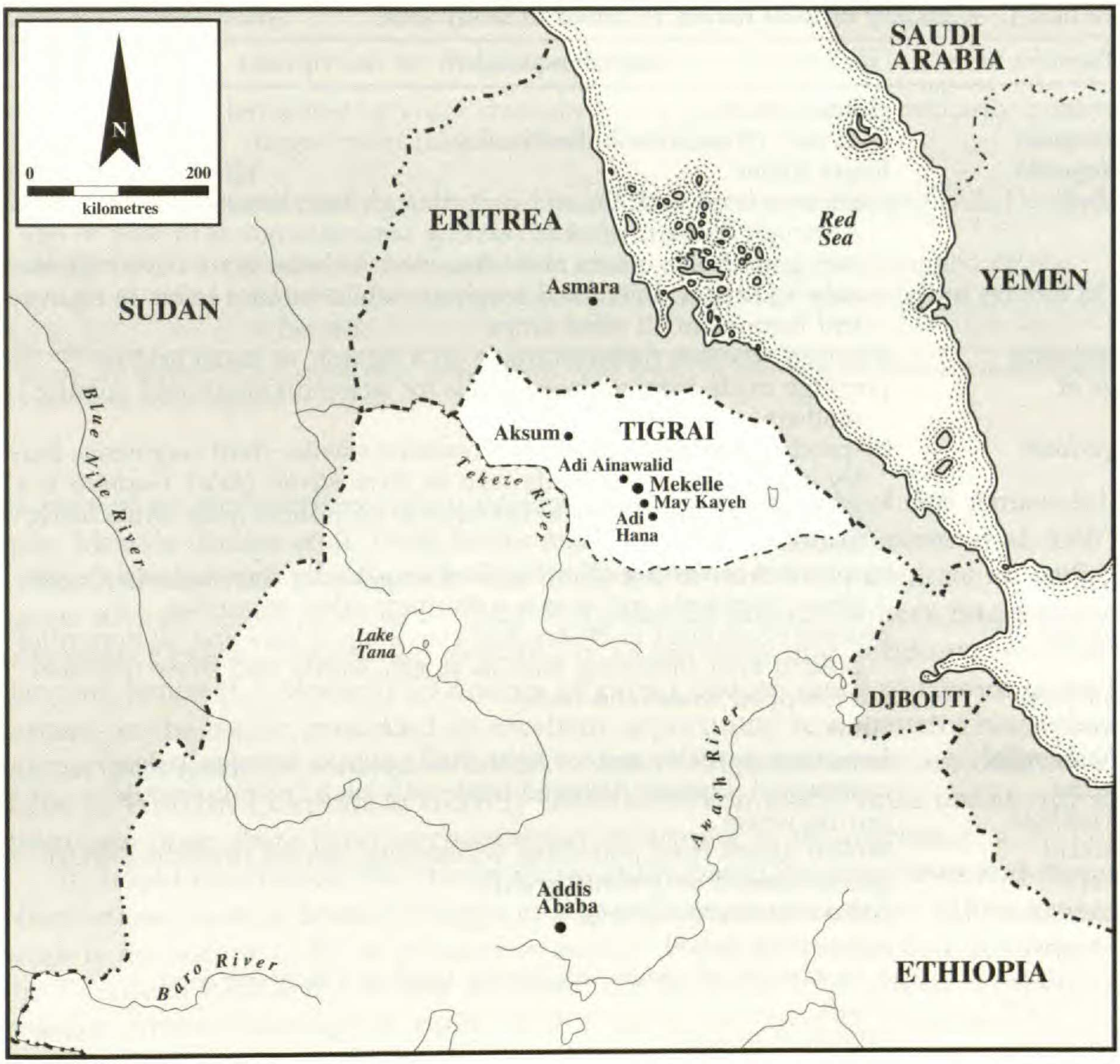


FIGURE 1.—The study area.

cereal processing identified from archaeological sites originate from these latter stages, including accidents of parching prior to pounding, winnowing and sieving before and after pounding, and storage of prime grain (Hillman 1984a:12). Although it is ill-advised to assume that gender roles in crop production are static in time and space, given the pattern evident in the ethnographic record, the possibility of using these kinds of remains as material correlates of men's and women's activities warrants serious investigation. Studies of gender based on paleoethnobotanical data are rare, but those that are available have produced valuable insights (e.g., Hastorf 1991; Watson and Kennedy 1991). Ethnoarchaeology has much to contribute to such research, and although the gendered division of labor in crop processing has been alluded to in some studies (e.g., Reddy 1991: 23), the relative contribution of males and females to these tasks has not been considered in detail.

Our study documents traditional emmer processing in and around the villages of Adi Hana and Mai Kayeh in south-central Tigrai, northeastern Ethiopia (Figure 1). Fieldwork was carried out in the autumn of 1997 and spring of 1998,

TABLE 1.—Glossary of local names recorded in study area.

Tigrinya terms*	English equivalent (or description)
arras	emmer wheat
burguda	land race of two-row hulled barley
dagusha	finger millet
ebuk	chaff associated with the ear, including glumes, lemmas, and paleas. Although the term ***ebuk*** is used by some informants to refer to emmer grain hulls, others insist that ***ebuk*** includes grain coverings of only tef, finger millet, and sorghum, while ***burkatz*** refers to equivalent features in all other crops
embasha	leavened wheaten flatbread made on a ceramic or metal griddle
ga'at	porridge made from various cereals for sick individuals and nursing mothers
guchach	by-product similar to ***gurdie*** but contains smaller chaff fragments, barley grains, and weed seeds such as *Avena sterilis* (***fa'a***). ***Guchach*** is a high quality fodder fed to donkeys to keep them quiet while being loaded
gulam	by-product consisting of unthreshed or partially threshed ears, large straw fragments and stones with many other impurities
gurdie	processing product or by-product consisting of ears and all impurities present after threshing, such as stones, weeds, and straw fragments
hanfetse	intercropped wheat and barley
haser	straw
haser nifai	fine straw particles and/or light chaff (glumes, lemmas, paleas)
kicha	unleavened wheaten flatbread made only on a ceramic griddle
kinkinai	durum wheat
kitkat	broken grains from pounding, winnowing, sieving (including flour)
kollo	grains roasted on a metal griddle
kurdad	*Lolium temulentum* grains
lameda	winnowing shovel
mahoyo	a soup made of grains, commonly used as a weaning food
makoster	brush
maresha	Ethiopian plough
mechelo	rake
menelik	mass-produced metal container commonly used in measuring grain/ flour, equivalent to about 650 ml
mentertar	winnowing technique using a ***sefi***
mese	winnowing fork
metahan	stone saddle quern
mihea	flat container with coarse apertures used in the field as a winnowing basket and in the household as a sieving/winnowing instrument
mihehai	sieving/winnowing technique using a ***mihea*** during household processing
mashila	sorghum
mogu	mortar
monfit	sieve
mofit tara	coarse sieve
monfit shi'i	fine sieve
mouk	thick soup made from flour
mubukats	an up-and-down motion used to toss products and by-products in household processing
saessea	two-row hulled barley land race
sefi	flat basket with no apertures, used in household winnowing
shahan	land race of bread wheat

TABLE 1.—(continued)

Tigrinya terms*	English equivalent (or description)
sua	fermented beverage consumed on a daily basis made primarily from finger millet (also sorghum and barley)
t'af	tef
taita	fermented pancake bread made from several cereals and baked only on a ceramic griddle (*injera* in Amharic)
tsumdi	measure of land equivalent to the area that can be ploughed by one team of oxen in one day, equivalent to approximately one quarter of a hectare.

* Terms are specific to the study area. Some words were found to have slightly different meanings in Aksum and other regions of Tigrai.

as part of an ethnoarchaeological project based at the village of Adi Ainawalid, near Mekelle (Butler et al. 1999; Butler and D'Andrea 2000; D'Andrea et al. 1997, 1999). Although the investigation was designed in part to concentrate on indigenous African cereals, such as tef (***t'af***;[3] *Eragrostis tef* (Zucc.) Trotter), finger millet (***dagusha***; *Eleusine coracana* ssp. *coracana* (L.) Gaertner), and sorghum (***mashila***; *Sorghum bicolor* (L.) Moench) (D'Andrea in prep.), the presence of emmer (***arras***) farmers in the region presented an excellent opportunity to document household emmer processing in a non-mechanized context (Tigrinya terms are defined in Table 1). With the exception of recently constructed communal mills used to grind grain into flour, there is no mechanization of farming in this region.

It should be stressed that this is a case study based on interviews and direct observations made at several villages in a specific geographic area.[4] Although this work is not meant to be an exhaustive survey of emmer production throughout the Ethiopian highlands, it does represent a solid basis from which to launch a broader ethnoarchaeological study of this cereal in Ethiopia. Furthermore, although an effort was made to record activities taking place prior to harvest, such as ploughing and sowing, acquiring these data was not a main priority of this research. Instead, we emphasize post-harvest activities and technology, which arguably have the greatest influence on archaeological preservation.

EMMER IN ETHIOPIA

The incredible diversity in Ethiopian wheats has been noted by many investigators (e.g., Chiovenda 1928; Ciferri and Giglioli 1939a, 1939b; Harlan 1969; Jain et al. 1975; Phillips 1995:61; Vavilov 1931, 1951). Vavilov (1951) considered Ethiopia a primary center of diversity for tetraploid[5] wheats, but it is now regarded as a secondary center (Engels and Hawkes 1991:27; Zeven and De Wet 1982:117). In Ethiopia wheat is grown under rainfed conditions over a range of elevations, but primarily between 1500 and 3000 m asl (Hailu 1991b:2; Tesfaye and Getachew 1991:48). Tetraploids occupy 60–70% of the total area of wheat under cultivation today, many of which are land races (Tesfaye 1991:289; Tesfaye and Getachew 1991:48). Of these, durum wheat predominates, and emmer is described as the most important minor wheat, although varietal diversity is not as pronounced as in durum (Hailu and Haile Mariam 1990:180).

Tetraploid wheats, including emmer, are believed to have a long history in Ethiopia, based on their evolution of diverse characteristics and numerous intermediate forms, which are most pronounced in durum (Engels and Hawkes 1991: 26–28; Hailu and Haile Mariam 1990:180; Tesfaye 1991:289–290). Some traits, such as purple grain color are endemic to Ethiopia (Getachew et al. 1995:387; Hailu and Haile Mariam 1990:182; Vavilov 1951:177; Zeven 1971). Claims have been made for the introduction of tetraploid wheats to Ethiopia as early as 5000 years ago (Engels and Hawkes 1991:28). Archaeobotanical evidence to date, however, indicates the presence of emmer by pre-Aksumite times, approximately 2500 years ago (Bard et al. 1997; Boardman 1999; Phillipson 2000). The importance of this cereal to the Aksumite empire is evident in its depiction on coins dating from the late third to early seventh centuries A.D., where ears of emmer are shown to encircle the heads of kings (Phillipson 1993:354–355). In contrast, hexaploid[6] wheats are thought to be relatively recent introductions (Ciferri and Giglioli 1939a:224–225; Engels and Hawkes 1991:28), and several opinions exist as to sources and timing (Hailu and Haile Mariam 1990:180–181). Some suggest seventeenth-century Portuguese traders (Chiovenda 1938; Ciferri and Giglioli 1939a: 225), while others propose that Italians were responsible for introductions (Hailu 1991a:75). Recent archaeobotanical finds of bread wheat at Aksum dating to the Late Aksumite period (mid-sixth to early seventh centuries A.D.) (Boardman 1999:142, 2000:367) suggest that hexaploids may have a longer history in Ethiopia than was previously thought.

Ethiopia represents one of the few remaining regions where emmer is cultivated for human consumption on a modest scale. It is estimated that emmer constitutes almost 7% of total wheat production (National Research Council 1996: 239), a figure down from 10% suggested by Ciferri and Giglioli (1939b:386) in the late 1930s. Bale province is reported to be the largest producer of this cereal, but it is commonly grown in several other areas (Abebe and Giorgis 1991:42). Agronomic interest in emmer improvement is overshadowed by the more economically significant durum wheat (see Hailu et al. 1991). Several taxonomic treatments are available, where varieties are defined based on features such as glume color (Ciferri and Giglioli 1939a:5–16; Percival 1921; Vavilov 1931). Observations on the uniqueness of Ethiopian emmer are made by Percival (1921:192, 1927:101) who demonstrates that Ethiopian and South Asian emmers have more than two vascular bundles in the coleoptile (Vavilov 1931:164–165, 1951:178). Harlan (1969: 313) postulates that the disjunct distribution of Indo-Abyssinian emmers indicates an "ancient primary distribution." These apparently unique features led Vavilov (1931:167, 1951:38) to suggest that Ethiopian emmer should be considered a separate species distinct even from those occurring in nearby Yemen. This view is not entirely supported by Ciferri and Giglioli (1939b:385–386) who conclude that the species status of Ethiopian emmer remains unresolved.

The survival of emmer cultivation in this region can be attributed to the isolation of the highlands in recent history, resulting in Ethiopia's lack of integration into the world economy. This has allowed the preservation of indigenous agricultural systems with little domination of cash crops in rural areas (Tewolde 1993: 219). As stated earlier, the replacement of hulled wheats by free-threshing forms in the Near East began in the fourth millennium B.C.; however, this was by no means a uniform process. Evidence indicates that pockets of emmer cultivation continued along with the growing of free-threshing wheat in Western Europe and other areas until the first millennium A.D. The persistence of emmer growing in some regions such as ancient Egypt has been explained by cultural preference. The overall decline of hulled wheats relates to a variety of factors, including agricultural intensification, to which free-threshing wheats responded better, and to changes in diet with the coming of industrialization and urbanism (Nesbitt and Samuel 1996:74–89). Interviews with Tigrayan farmers indicate that emmer is declining in importance because of its relatively low productivity and onerous processing requirements. It is nevertheless still highly valued for its taste and texture in certain prepared foods.

EMMER HUSBANDRY IN SOUTH-CENTRAL TIGRAI

We collected data from several villages in south-central Tigrai, including Adi Hana and Mai Kayeh. The area corresponds to a northern emmer-growing district described and mapped by Ciferri and Giglioli (1939a:270). In this region, emmer is grown regularly for human consumption as a monocrop and intercropped with other wheats and barleys, including ***burguda*** and ***saessea*** land races of two-row hulled barley (*Hordeum vulgare* ssp. *distichum* L.), ***kinkinai*** or durum and ***shahan*** wheat (*T. aestivum* ssp. *vulgare* (Vill) MacKay). In the villages surrounding Adi Hana and Mai Kayeh, emmer is grown on a small scale primarily for household use, although farmers occasionally sell clean grain in regional markets. The market value of grain is twice that of spikelets, and it is almost always sold as dehusked grain.

Ploughing for emmer and other cereals in the region occurs anytime from January to July (D'Andrea et al. 1999:110). As in other regions of Ethiopia, the availability of oxen is a main determinant of how much ploughing is accomplished in a given year. Farmers prefer to plough each field as many as six or seven times, but two or three is more common (Bauer 1975; D'Andrea et al. 1999:110; McCann 1995:78–79). Informants used the ***maresha*** plough, which is not capable of deep ploughing (Goe 1990); thus several passes are preferred.

Emmer is sown broadcast in spikelet form (see Hillman 1984b:116), and farmers consider the idea of sowing clean grain quite humorous. When asked if sowing clean grain ever takes place, several informants laughed and replied with a rhetorical question, along the lines of, "Why would anyone do such a thing?" One informant responded with the following story:

> "One spring, a woman who had grown weary of pounding emmer gave clean grain to her husband to sow in the hopes that the ensuing harvest would produce grain free of hulls. However, the harvest produced the familiar hulled grains, so she had to pound them anyway. In the end she decided that sowing hulled emmer actually saved her work, and she was very pleased with this discovery."

Weeding is rare and culling is not practiced. During harvest, plants are normally cut about 5 cm above the ground surface using a sickle, in a manner similar to other wheats and barley. They are also harvested by uprooting using a sickle (cf. Hillman 1984b:117–118). After harvesting, plants are left to dry in small heaps in the field. The length of time before threshing varies from immediately to one or two weeks following harvest, depending upon work schedules and other obligations of the farmer, rather than on a perceived need to dry the harvest under normal conditions. There are no ceremonial activities specifically associated with emmer harvesting or threshing. The drinking of a locally-made fermented beverage known as ***sua*** and eating ***embasha*** bread with butter occurs after the threshing of any crop. There also is a short prayer recited at the end of threshing for which many informants requested privacy. If the harvest is small, farmers usually do not bother with these customs. Harvest usually occurs from October to December (mainly November), and normally there is no gleaning.

Intercropping is a worldwide feature of traditional agricultural systems. It is believed to be an ancient practice that confers several advantages to farmers (Innis 1997:1–33). This technique is commonly encountered in Tigrai and adjacent regions (Butler 2000:468–469; D'Andrea et al. 1999:111–112; Holt and Lawrence 1993:68; Simon 1993:38; Simoons 1960:170–171). Emmer is often intercropped with other cereals, and the mixtures used are diverse, involving two or more crops. The highest number observed in the study area is three. Varying degrees of concern are expressed by farmers on proportions of different crops sown at one time, but observations of emmer are similar to those reported for ***hanfetse*** (intercropped bread wheat and barley) in Adi Ainawalid (D'Andrea et al. 1999:111). The intercropping ratio between ***shahan*** wheat and emmer varies from 2:1 (***shahan***:emmer) to 1:1. After successive replanting, emmer eventually dominates, but ***shahan*** wheat has a higher market value, and this is one reason why farmers prefer the 2:1 ratio. Another reason given is that this ratio produces the best-quality flour for making the local unleavened pancake bread known as ***taita*** (***injera*** in Amharic). Women will either add ***shahan*** or remove emmer by hand-separating to achieve this proportion, then proceed to mill the mixed grains. Flexibility in proportions sown also occurs if there is a shortage of ***shahan*** wheat seed for sowing in a given year, and the balance can be made up with emmer. Emmer is also mixed with ***burguda*** barley in this manner and for the same reasons, with ratios also varying from 2:1 (***burguda***:emmer) to 1:1. In cases where three crops are interplanted, the preferred proportions are 2:2:1 (***burguda***:***shahan***:emmer), and such mixtures can include multiple land races of barley.

Emmer cultivation is in decline in central Tigrai, and for several reasons has disappeared altogether from many areas. Although yields can be relatively high, in general, the growing of both emmer and durum wheat has been curtailed because of land and water shortages. As a result only wealthier families possess sufficient land and other resources to grow emmer. Another factor in the reduction of emmer production in Adi Hana and May Kayeh is the processing cost. Pounding is required to dehusk the grain, and informants consider this very labor intensive. Although a high regard is shown for the grain qualities, elder women describe working with emmer with a sense of displeasure or at the very least relief that they are no longer obliged to pound the spikelets (cf. Hillman 1984b:140). The persistence of emmer growing is most certainly the result of farmers' appreciation for the foods produced (see below). In addition, Ciferri and Giglioli

(1939b:386) suggest that emmer cultivation has continued in some areas because it has adapted well to elevations of 2600 m asl and above.

POST-HARVEST TECHNOLOGY

We observed one field threshing episode and three household processing sequences. These data are supplemented by several interviews where verbal accounts and/or demonstrations by informants were provided. The post-harvest treatment of emmer and other cereals can be divided into two stages based on location of activity and individuals responsible for the work. Field processing is supervised by men with the participation of women, and includes threshing and winnowing. It culminates in the production of ***haser*** (straw), semi-clean spikelets, and ***gurdie*** (comprised of incompletely threshed ears and several impurities, such as stones, weeds, and straw fragments) (Figure 2). These activities usually take place in harvested fields away from the domestic compound. Women are responsible for household processing, which involves several operations that result in the production of clean grain and various by-products (Figures 3 and 4). The circled numbers in these figures represent samples taken from processing stages, which correspond to those listed in Tables 2 and 3. Although our original intent was to quantify processing residues to assist in the interpretation of archaeobotanical data, it was not possible to obtain sufficiently large samples for analysis because agricultural production and processing in this region is typically small scale. This situation was exacerbated during fieldwork when farmers were experiencing food shortages due to impoverished harvests. Individual sample sizes ranged from 15.1–32.9 g for field threshing and 1.1–19.0 g for household processing. As a result, statistical analysis of processing products and by-products (Hillman 1984a; Jones 1984; Jones and Halstead 1995) is not attempted here. Residues collected at each stage were identified and listed in Tables 2 and 3[7] in order of decreasing frequency of fragment counts. Although the use of these data in the direct interpretation of archaeobotanical remains is limited, observed patterns can be used to suggest possibilities for future quantitative studies. The product/by-product names and chaff terms used in Tables 2 and 3 originate from informants whose verbal descriptions corroborate extremely well with elements identified in the residues.

It is not surprising that minor differences in procedures followed by Tigrayan informants were observed. It is necessary to comment on the potential significance of this variation, as well as the degree of generalization possible from these data. The sequence in Figure 2 represents the only field processing episode observed in its entirety, but descriptions from other farmers are strongly consistent, indicating that it represents a good approximation of general practice. The household processing pathway illustrated in Figures 3 and 4 represents a summary of observations from three main informants, two of whom provided consistent answers in three separate interviews (two to four hours) separated by several months. In addition, these two informants and their extended families have grown emmer throughout their living memory. Samples obtained during the course of one processing event are described in Table 3. Although it may be premature to extend these sequences to all emmer producing regions of Ethiopia, they are certainly

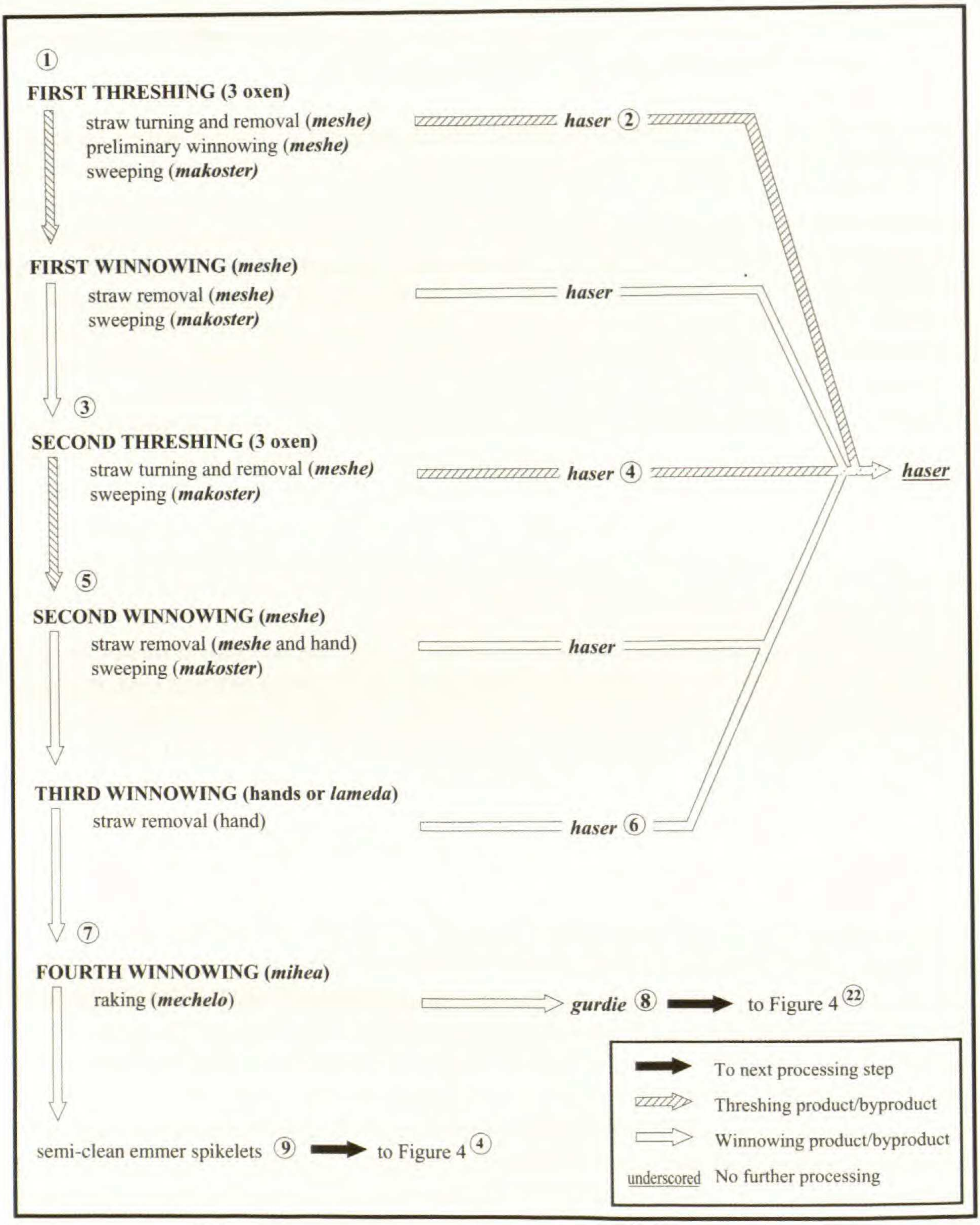


FIGURE 2.—Field processing sequence of emmer, Adi Hana.

representative of Adi Hana and Mai Kayeh. Moreover, interviews conducted in nearby villages where emmer growing has been discontinued indicate that these data may have a broadly regional applicability. At Adi Ainawalid, for example, elder men and women interviewed about their recollections of emmer processing provided detailed information that accurately reflect activities of Adi Hana and Mai Kayeh farmers documented in this study.

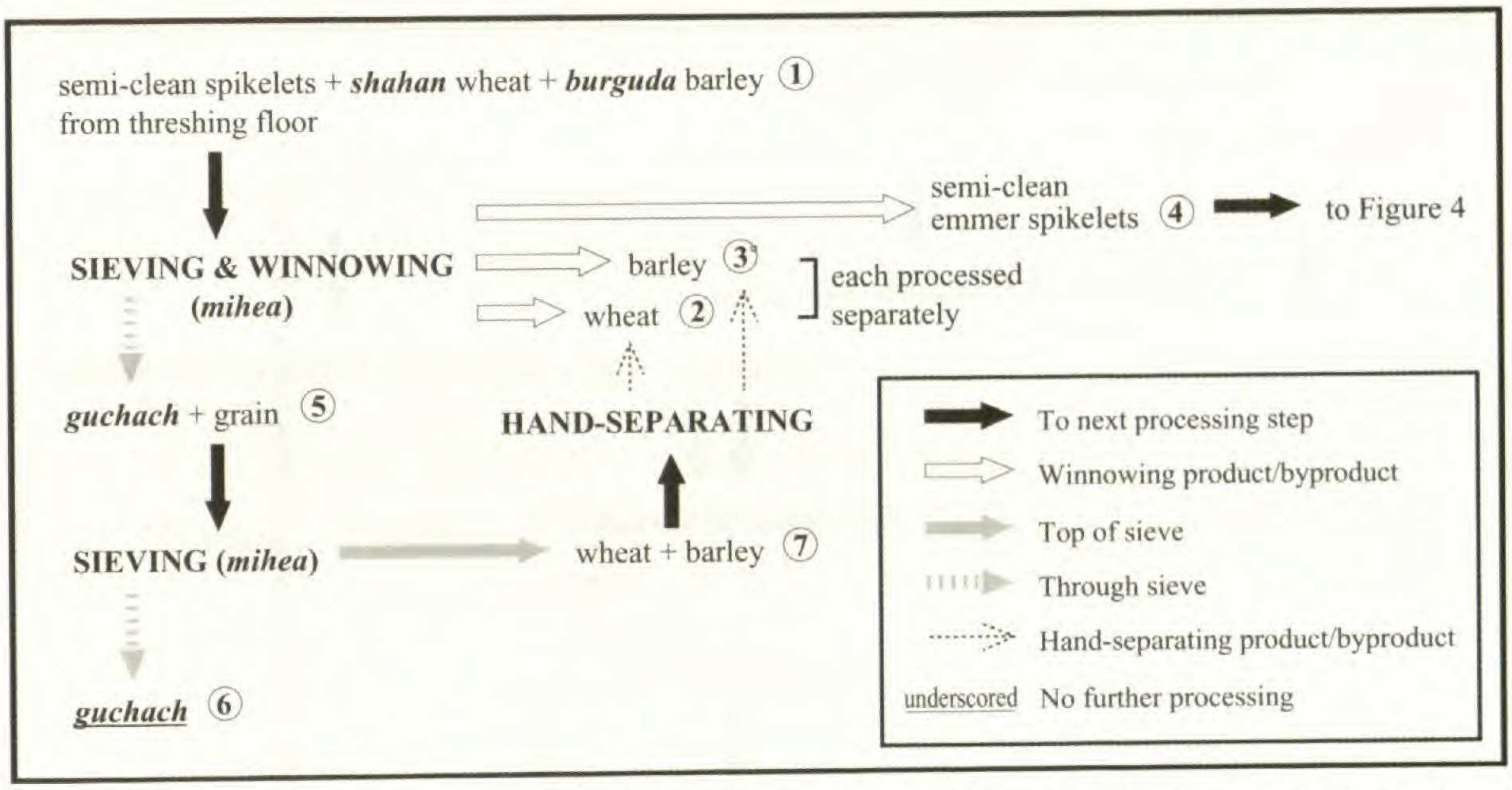


FIGURE 3.—Preliminary household processing of a mixed harvest of emmer, ***shahan*** wheat and ***burguda*** barley, Adi Hana.

Tools used in processing will be described more fully elsewhere (D'Andrea in prep.), but include a flat winnowing basket with coarse apertures that also acts as a sieve (***mihea***), fine and coarse sieves (***monfit***), a flat circular winnowing tray without apertures (***sefi***), wooden mortar (***mogu***) (Figure 5), two- and three-pronged wooden winnowing forks (***mese***), and brush-like instruments used in sweeping (***makoster***) and raking (***mechelo***). All implements are made from locally available grasses and woods, while brushes are fashioned from available dried shrubbery.

Field Processing.—One complete threshing of a small emmer harvest was observed in Adi Hana. The processing steps are summarized in Figure 2, while Table 2 provides a description of residues produced at each stage. The crop was harvested the previous day from 1/2 ***tsumdi*** or 1/8 hectare of land which took the farmer one day to harvest. It was sown with 70 ***menelik*** or approximately 46 liters of spikelets, which were obtained from the previous year's crop. This harvest produced an estimated 25 kg of spikelets, and was characterized by the farmer and other informants as a very poor yield.

Threshing operations are supervised by men, who are assisted by younger children of both sexes and occasionally by women. Threshing of all crops is accompanied by singing threshing songs and energetic exclamations of "hey-ho, hey-ho, hey-ho. . ." This is thought to focus the energy of the farmer and to spur on the oxen. Threshing takes place on a flattened circular area, the surface of which is prepared by sweeping with a ***makoster***. Occasionally, the threshing floor is coated with a dung and water mixture, which after drying in the sun, produces a uniform surface. This is done specifically for tef, which is threshed first; other crops follow (D'Andrea et al. 1999:112). The harvest is spread evenly on the floor and first threshing is conducted with three or more oxen (Figure 6). Farmers use a two-pronged wooden ***mese*** (winnowing fork) to turn the straw as threshing

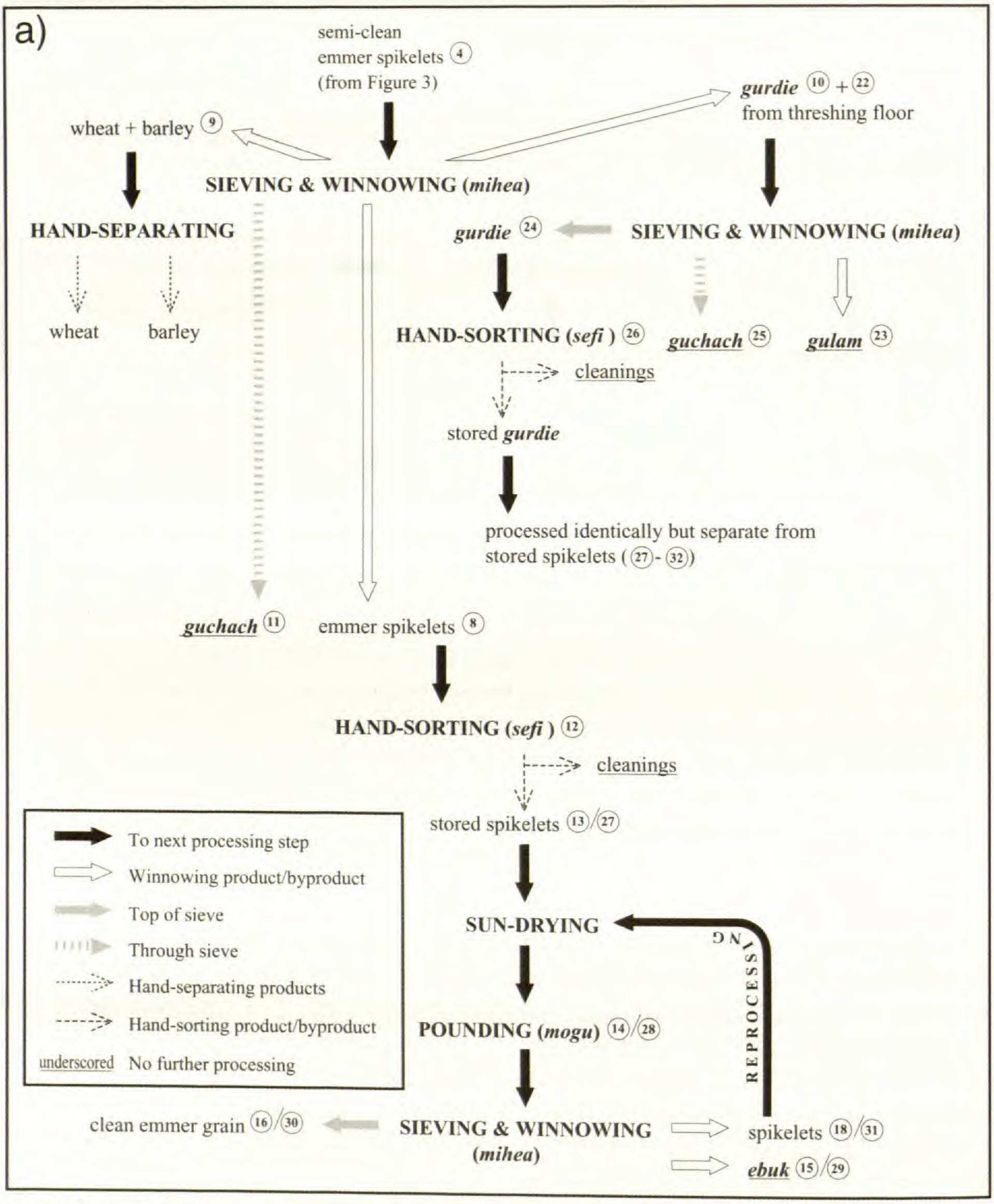
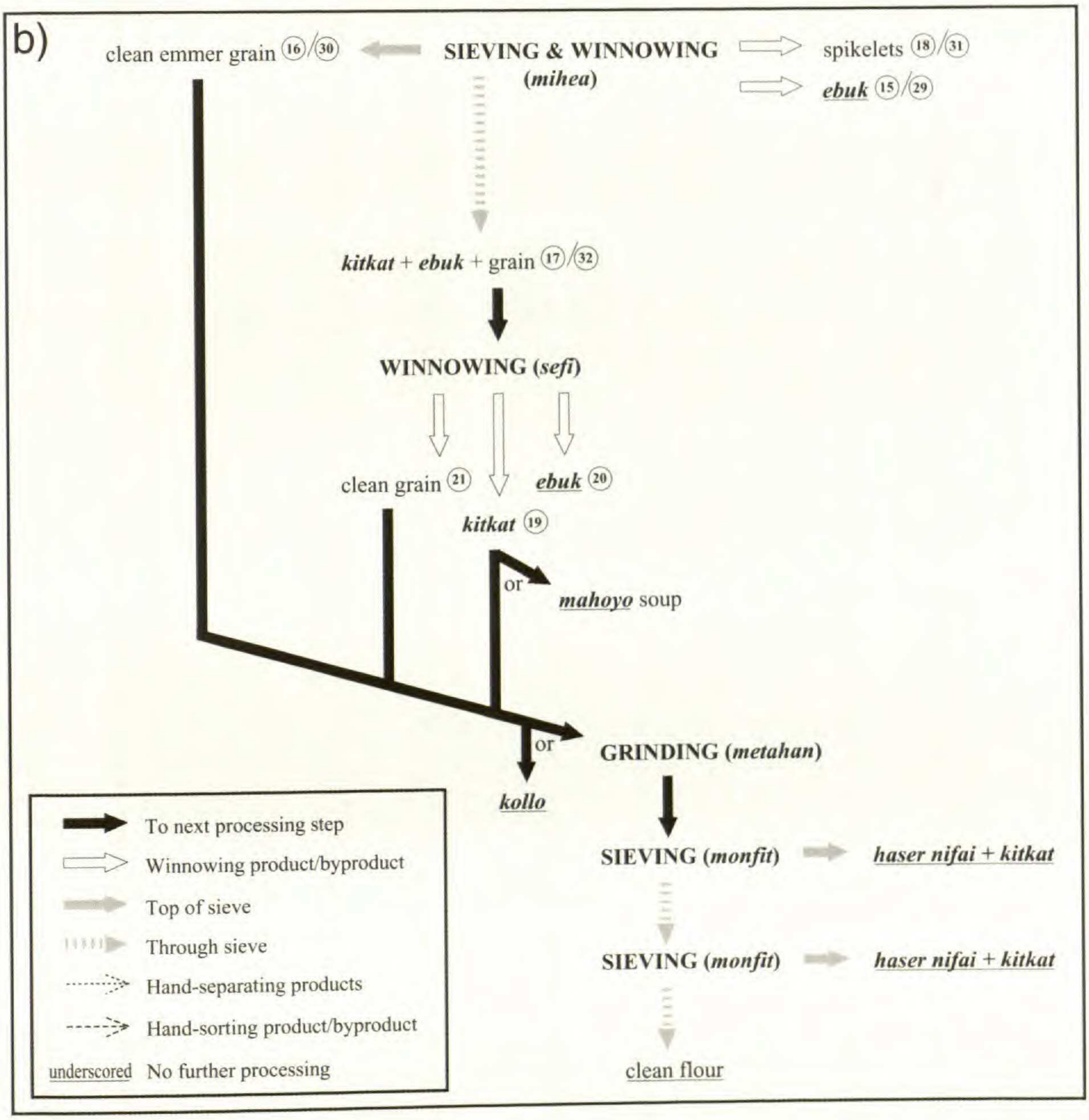


FIGURE 4.—Household processing sequence of emmer, Adi Hana. The sieving and winnowing step at the bottom of page 190 is repeated at the top of page 191.

progresses. Toward the end of first threshing, while oxen continue trampling, some preliminary winnowing takes place as the harvest is tossed into the wind using a two-pronged fork. Several farmers stated that normally only one threshing is necessary, and in general emmer is much easier to thresh than other cereals. However, during the 1997 harvest season, emmer required two or more threshings because unseasonable rains resulted in high moisture levels in all harvested crops. A similar observation is made by Hillman (1984b:125) concerning the processing



of glume wheats in Turkey, where one threshing is sufficient except when the harvest is damp or unripe. First threshing ends with sweeping the threshing floor and consolidating the harvest using a ***makoster***. First winnowing proceeds with a two-pronged ***mese*** which is used to toss the harvest into the wind and to remove straw which is piled along the periphery of the threshing floor (Figure 7). If a three-pronged fork is available, it is used at this stage because it is more effective in picking up smaller straw fragments. First winnowing ends by consolidating the harvest by sweeping with a ***makoster***.

Oxen are returned to the threshing floor for second threshing (if necessary) where straw continues to be turned over and removed. At the end of this stage, the harvest is again consolidated in the center of the floor by sweeping. It is followed by second winnowing using a two- or (preferably) three-pronged winnowing fork. Straw is removed by hand, and the harvest is consolidated by sweep-

TABLE 2.—Field processing residues: emmer (see Figure 2 for processing pathway).

Sample	Wt. (g)	Product/by-product	Description
1	24.9	unthreshed emmer	**complete emmer plants with roots attached**†
2	18.4	straw removed during first threshing	**straw from middle to bottom half of emmer plants,** partially threshed spikelets‡; spikes/fruit (*Cynodon dactylon* (L.) Pers., *Brassica,* grass pea)
3	15.1	floor sample at end of first winnowing	**straw fragments,** threshed spikelets, partially threshed spikelets, complete ears; seeds (*Avena sterilis,* barley, *Scorpiurus mucronatus* L., *Brassica,* Lamiaceae); spikes/fruits (*C. dactylon, Comicarpus*)
4	16.8	straw removed during second threshing	**straw from middle to bottom half of emmer plants,** straw with 1–2 basal spikelets attached, partially threshed spikelets, threshed spikelets; spikes/fruits (*C. dactylon, A. sterilis,* indeterminate flower head, *Brassica, Polypogon, Eragrostis*)
5	18.4	floor sample at end of second threshing	**threshed spikelets,** partially threshed spikelets, straw fragments; seeds (*A. sterilis,* emmer, barley, grass pea, fenugreek, wheat); spikes/fruits (*Comicarpus, C. dactylon, Sonchus oleraceus* L.)
6	32.8	straw removed during third winnowing	**straw from middle of plant,** threshed spikelets, partially threshed spikelets, straw with 1–2 basal spikelets attached; spikes/fruits (*A. sterilis, Comicarpus, S. mucronatus, C. dactylon,* Lamiaceae, fenugreek, *Polypogon, Ammi majus* L., *S. oleraceus*)
7	18.0	floor sample at end of third winnowing	**threshed spikelets, partially threshed spikelets, straw fragments**; seeds (*A. sterilis,* wheat, barley, emmer, fenugreek; spikes/fruits (*C. dactylon, S. oleraceus*)
8	18.1	*gurdie*	**partially threshed spikelets, straw with 1–2 basal spikelets attached,** threshed spikelets, straw fragments; seeds (*A. sterilis, S. mucronatus,* fenugreek)
9	32.9	semi-clean spikelets	**threshed spikelets,** partially threshed spikelets, straw with 1–2 basal spikelets attached; seeds (*A. sterilis,* fenugreek, barley, wheat, emmer, grass pea, lentil, Fabaceae, chickpea, *Lolium temulentum, S. mucronatus*); spikes/fruits (*Comicarpus*)

* Residues are listed in the following order: all emmer elements; loose seeds; spikes/fruits. Within each category, items are listed in decreasing frequency based on raw counts.

† Dominating elements, where present, are in boldface.

‡ Partially threshed spikelets represent two or more attached spikelets.

TABLE 3.—Household processing residues: intercropped emmer, ***shahan*** wheat and ***burguda*** barley (see Figures 3, 4 for processing pathway).

Sample	Wt. (g)	Product/by-product	Description*
1	15.3	semi-clean spikelets	**barley**†, **wheat, threshed spikelets,** *A. sterilis,* empty glumes, partially threshed spikelets‡, *S. mucronatus, Brassica,* Asteraceae flower, cf. Zygophyllaceae, dung/stones
2	14.5	wheat	**wheat,** barley, *A. sterilis, Brassica,* dung/stones
3	12.8	barley	**barley,** wheat, *A. sterilis,* threshed spikelets, dung/stones
4	18.4	semi-clean spikelets	**threshed spikelets, barley,** *A. sterilis,* wheat, *S. mucronatus,* cf. Zygophyllaceae, partially threshed spikelets, Asteraceae flower
5	18.3	***guchach*** + grain	**wheat, barley, *A. sterilis,*** threshed spikelets, indeterminate flowers, *L. temulentum, S. mucronatus,* flax, Solanaceae, Asteraceae flower, dung/stones
6	13.3	***guchach***	**barley, wheat, *A. sterilis,*** threshed spikelets, straw fragments, Asteraceae flowers, empty glumes, *S. mucronatus, L. temulentum,* flax, Apiaceae, dung/stones
7	16.5	wheat + barley	**wheat, barley,** *A. sterilis,* flax, dung/stones, diseased rachis/ears
8	13.4	emmer spikelets	**threshed spikelets,** barley, *A. sterilis,* wheat *S. mucronatus,* diseased rachis/ears, dung/stones
9	16.5	wheat + barley	**barley,** wheat, threshed spikelets, *A. sterilis,* cf. Zygophyllaceae, dung/stones
10	9.7	***gurdie***	**threshed spikelets, partially threshed spikelets,** straw fragments, barley, *A. sterilis,* straw with 1–2 basal spikelets attached; *S. mucronatus,* Asteraceae flower, *Medicago,* cf. Zygophyllaceae, diseased rachis/ear, dung/stones
11	10.6	***guchach***	**barley, *A. sterilis,*** threshed spikelets, wheat, straw fragments, *S. mucronatus,* Asteraceae flowers, partially threshed spikelets, *L. temulentum,* cf. Zygophyllaceae, dung/stones
12	3.2	cleanings from hand-sorting	**diseased rachis/ears,** *S. mucronatus,* cf. Zygophyllaceae, barley, indeterminate plant, straw fragments, Asteraceae flowers, *A. sterilis,* barley rachis, *Brassica* siliques, sorghum, dung/stones
13	8.1	stored spikelets	**threshed spikelets,** barley, *A. sterilis,* partially threshed spikelets, wheat, *S. mucronatus*
14	17.0	pounding product/by-product	**threshed spikelets,** empty glumes, broken emmer, emmer, barley, *A. sterilis,* wheat

TABLE 3.—(continued)

Sample	Wt. (g)	Product/by-product	Description*
15	1.1	*ebuk*	**empty glumes,** threshed spikelets, *A. sterilis,* straw fragments, dung/stones
16	8.2	clean emmer grain	**emmer, barley,** broken emmer, wheat, *A. sterilis,* threshed spikelets, cf. Zygophyllaceae, empty glumes
17	7.0	***kitkat*** + ***ebuk*** + grain	**empty glumes, broken emmer,** emmer, broken barley, barley, wheat, *A. sterilis,* threshed spikelets, *S. mucronatus,* Trifoleae, diseased rachis/ears
18	9.2	spikelets for reprocessing	**threshed spikelets,** empty glumes, *A. sterilis,* barley, broken emmer, emmer, broken barley, cf. Zygophyllaceae
19	7.5	***kitkat***	**broken emmer,** emmer, wheat, broken barley, *A. sterilis,* barley, diseased rachis/ears, *S. mucronatus,* Trifoleae
20	4.9	*ebuk*	**empty glumes,** broken emmer, broken barley, *A. sterilis,* indeterminate crushed grain, threshed spikelets, barley, *L. temulentum,* wheat, *S. mucronatus,* cf. Zygophyllaceae, dung/stones
21	7.0	clean emmer grain	**emmer, broken emmer,** threshed spikelets, broken barley, barley, *A. sterilis,* wheat empty glumes, *S. mucronatus,* straw fragments, Trifoleae, Poaceae
22	12.6	*gurdie* from threshing floor	**threshed spikelets,** partially threshed spikelets, straw fragments, barley, *A. sterilis,* barley rachis, *S. mucronatus, Medicago,* wheat, *L. temulentum,* dung/stones, indeterminate plant
23	5.0	*gulam*	partially threshed spikelets, straw fragments, indeterminate plant, barley, barley rachis *A. sterilis, S. mucronatus, Medicago,* straw with 1–2 basal spikelets attached, *Trifolium* flower, *L. temulentum,* Poaceae
24	11.9	*gurdie*	**threshed spikelets,** partially threshed spikelets, barley, *A. sterilis,* empty glumes, *S. mucronatus,* wheat, straw fragments, cf. Zygophyllaceae, *Medicago,* indeterminate plant, dung/stones
25	5.2	*guchach*	**barley, *A. sterilis,*** straw fragments, empty glumes, threshed spikelets, wheat, indeterminate plant, broken emmer, *L. temulentum, S. mucronatus,* cf. Zygophyllaceae, partially threshed spikelets, *Brassica, Medicago,* Asteraceae flower, dung/stones
26	5.3	cleanings from hand-sorting	*S. mucronatus,* dung/stones, *Medicago,* disease rachis/ears, indeterminate plant, barley, cf. Zygophyllaceae, Asteraceae flower, straw fragments, threshed spikelets, empty glumes, *Brassica*

TABLE 3.—(continued)

Sample	Wt. (g)	Product/by-product	Description*
27	19.0	stored spikelets (*gurdie*)	**threshed spikelets,** partially threshed spikelets, barley, *A. sterilis,* straw fragments, *S. mucronatus,* wheat, barley rachis, empty glumes, indeterminate plant, broken emmer, dung/stones
28	12.7	pounded product/by-product (*gurdie*)	**threshed spikelets, empty glumes,** broken emmer, emmer, broken barley, *A. sterilis,* barley, wheat, partially threshed spikelets, *S. mucronatus,* straw fragments, cf. Zygophyllaceae, *Medicago,* Trifoleae, Poaceae, indeterminate plant
29	6.6	***ebuk*** (*gurdie*)	**empty glumes, threshed spikelets,** broken emmer, *S. mucronatus, A. sterilis,* straw fragments, broken barley, straw with 1–2 basal spikelets attached, *L. temulentum,* indeterminate plant, cf. Zygophyllaceae, dung/stones
30	9.4	clean emmer grain (*gurdie*)	**emmer, broken emmer,** barley, wheat, threshed spikelets, empty glumes, *A. sterilis,* cf. Zygophyllaceae, dung/stones
31	12.0	spikelets for reprocessing (*gurdie*)	**threshed spikelets,** empty glumes, broken emmer, barley, *A. sterilis,* emmer, partially threshed spikelets, *Medicago,* cf. Zygophyllaceae, straw fragments
32	8.6	***kitkat*** + ***ebuk*** + grain (*gurdie*)	**empty glumes,** broken emmer, broken barley, emmer, barley, *A. sterilis,* wheat, *S. mucronatus,* indeterminate plant, Trifoleae, straw fragments, barley rachis, Asteraceae flower, diseased rachis/ears

* All elements are listed in decreasing frequency based on raw counts. All plant remains refer to seeds unless specified otherwise.
† Dominating elements within each sample, where present, are in boldface.
‡ Partially threshed spikelets represent two or more attached spikelets.

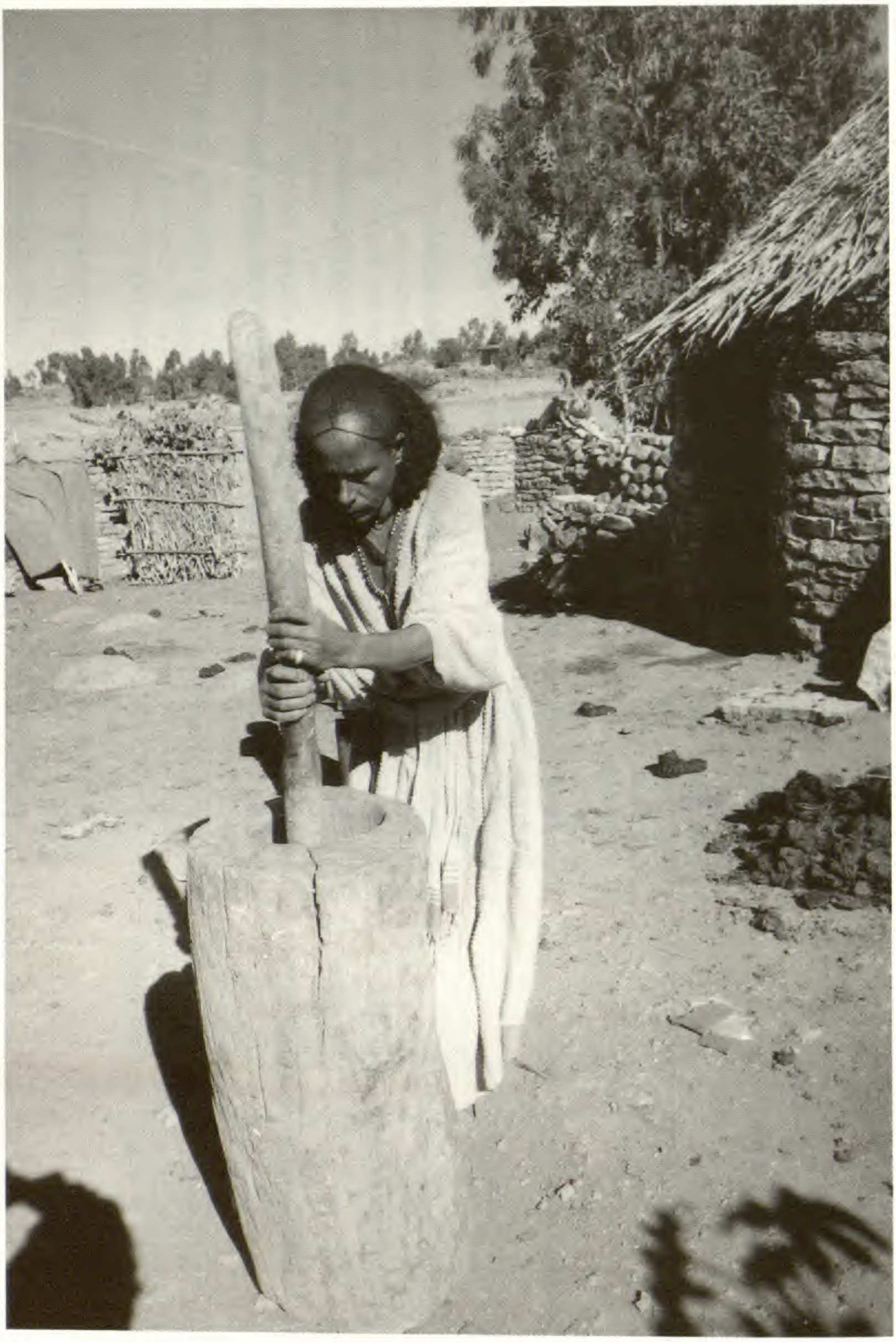


FIGURE 5.—Wayzaro Halufti Tesfaye pounding grain with a ***mogu***, Adi Ainawalid.

ing with a ***makoster*** in preparation for third winnowing. If the harvest is large, a ***lameda*** (winnowing shovel) is employed at this stage, but in small harvests, winnowing by hand is practiced. In this activity, two people facing each other and joining hands beneath the harvest lift a large portion and let it fall into the wind (Figure 8). Larger fragments of straw are removed by hand. This winnowing method has not been previously reported in the literature (e.g., Hillman 1984b;

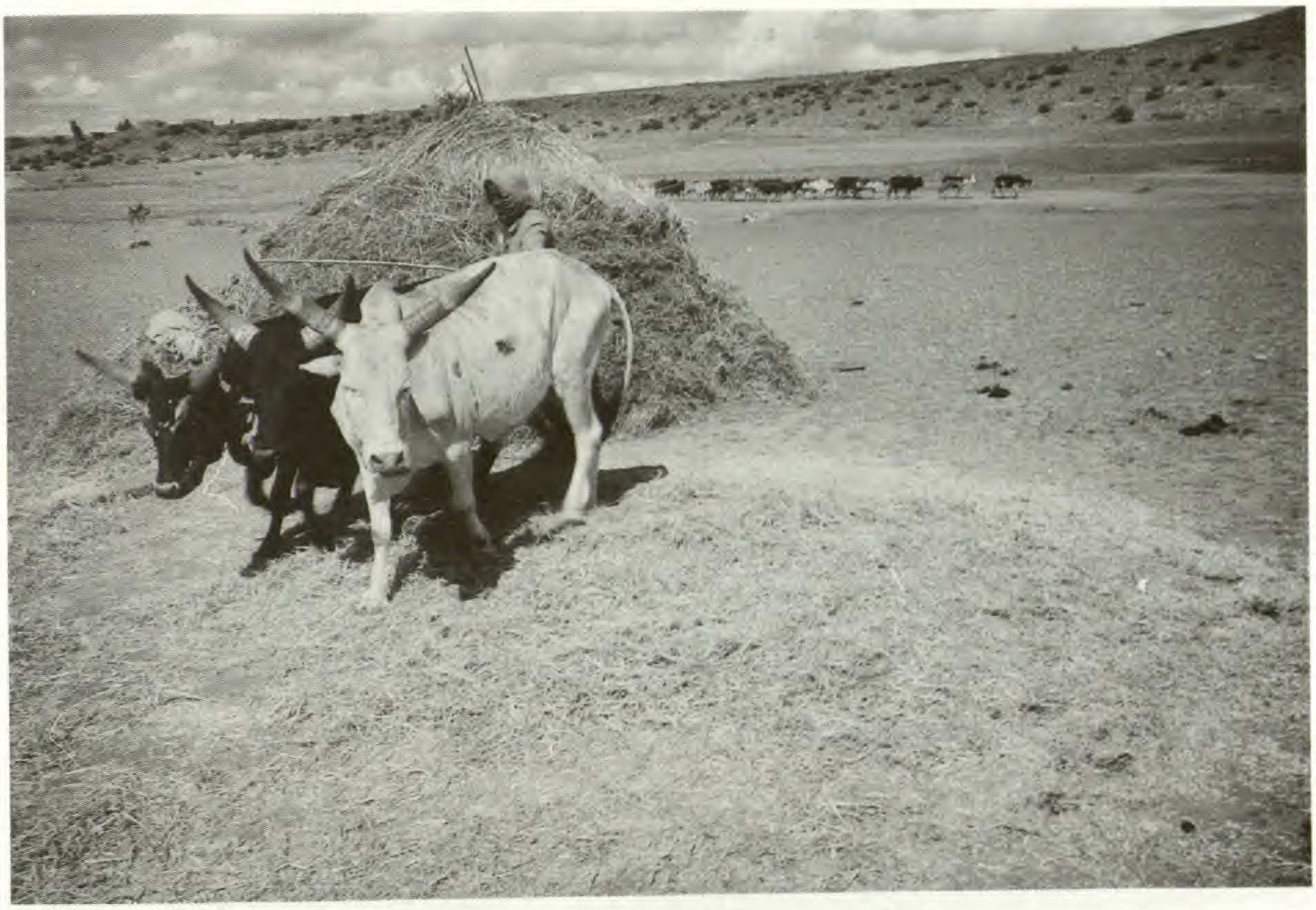


FIGURE 6.—First threshing of emmer, Adi Hana.

FIGURE 7.—First winnowing using a *meshe*, Adi Hana.

FIGURE 8.—Third winnowing of emmer by hand, Adi Hana.

Murray 2000; Samuel 1993), and may represent a technique employed with particularly small harvests. Fourth winnowing proceeds using a ***mihea,*** where basketfuls of harvest are lifted and dropped into the wind, with spikelets accumulating at the feet of the winnower (Figure 9). During this activity, dust and small chaff elements pass through the ***mihea*** as well, but the activity is primarily winnowing. After each basketful, the surface of the spikelet pile is raked using a ***mechelo.*** This action produces two accumulations which are bagged separately: semi-clean spikelets at the foot of the winnower, and ***gurdie*** which is raked aside by the ***mechelo***.

Field processing results in the production of one by-product (straw) and two products (semi-clean spikelets and ***gurdie***), all of which are transported to the residential compound by donkey or human carriers. Emmer straw is used mainly as fodder, and has no special uses to distinguish it from wheat and barley straw. It is stored outdoors in a designated area next to the residential compound, and is subjected to no additional processing prior to being fed to livestock. Wheat and especially barley straw are preferred in the production of dung cakes which constitute the most important domestic fuel. Straw is added only during the rainy season because dung tends to be more viscous at this time, and the added straw facilitates drying and improves burning quality. Unlike India and other regions where dung fuel production takes place only during the dry season (Reddy 1999: 63), this activity continues throughout the year in the Ethiopian highlands. Chopped wheat and barley straw is not used in making mortar, but can be com-

FIGURE 9.—Fourth winnowing using a ***mihea***, Ato Abraha Kidanu, Adi Ainawalid.

bined with clay to plaster interior walls of houses, especially in the first layers applied to new walls.

Household Processing.—The processing of semi-clean spikelets and ***gurdie*** takes place entirely in the household, under the supervision of women with virtually no involvement by men. When semi-clean spikelets arrive from the threshing floor, they are cleaned and processed in the following steps with a remarkable degree of consistency: 1) sieving/winnowing (***mihehai***), 2) hand-sorting,[8] 3) sun-drying, 4) pounding, 5) sieving/winnowing (***mihehai***), hand-sorting and reprocessing if necessary, 6) winnowing (***mentertar***), 7) grinding (milling) into flour or whole grains used in food preparation, 8) flour sieving, 9) food preparation from flour.

In this sequence, slight variation occurred in the order of sieving/winnowing and hand-sorting in steps 1, 2 and 5. Observed differences depend on several factors including personal preference, economic conditions, and effectiveness of the previous processing operation. Personal preference introduces variation and can be related to skill level as well as available equipment. For example, a ***mihea*** is normally used in the initial stages of household winnowing, but a ***sefi*** can be substituted if necessary. In terms of economic situation, informants mentioned that at several stages, products used as fodder can be further processed to extract more grain, in the case of food shortages. In addition, fine chaff removed at various stages in household processing is sometimes used as fodder and other times discarded on compound floors, depending on fodder availability. Such fine cleanings are not used in making dung cakes for fuel. Finally, success of cleaning in previous stages can determine the type of operation; in particular, the most common step added for this reason was extra hand-sorting or winnowing. Except for a reversal in pounding and drying steps, this processing pathway compares reasonably well with reconstructions of emmer processing from ancient Egyptian archaeological and textual data (Samuel 1999:130, 2000:541), and at a general level with ethnographic studies in Turkey (Hillman 1984b). Further comparisons are discussed below.

The particular case illustrated in Figures 3 and 4 involved the processing of a harvest of a mixed crop of emmer, ***shahan*** wheat, and ***burguda*** barley. Descriptions of residues produced at each processing stage are summarized in Table 3. These mixtures can be processed together entirely (including grinding to produce flour), but more commonly, grains are separated at an early stage in the processing sequence, as illustrated in Figure 3. The subsequent treatment of emmer spikelets depicted in Figure 4 is not affected by the early removal of these other cereals. The overall character of residues, however, certainly is influenced by the presence of barley and wheat grains, which would not be expected to occur in large quantities in a monocropped harvest of emmer.

The mixed crop arrives in the household from the threshing floor in two forms (excluding straw): semi-clean spikelets mixed with wheat and barley grains and ***gurdie***. As illustrated in Figure 3, the mixture of threshed spikelets and grain is first sieved and winnowed using a ***mihea***. This simultaneous sieving and winnowing action has no English term, but is termed ***mihehai*** in Tigrinyna (Figure 10). In ***mihehai***, women employ a sideways and circular motion which is designed

FIGURE 10.—The *mihehai* technique, Wayzaro Yalemser Asbaha, Adi Hana.

to make fine impurities such as small weed seeds and dust fall through the ***mihea.*** As such this technique is roughly equivalent to fine sieving where products are retained by the sieve allowing impurities to pass through (Jones 1984:46). Materials are also tossed on the ***mihea*** and air is blown from the winnower's mouth,

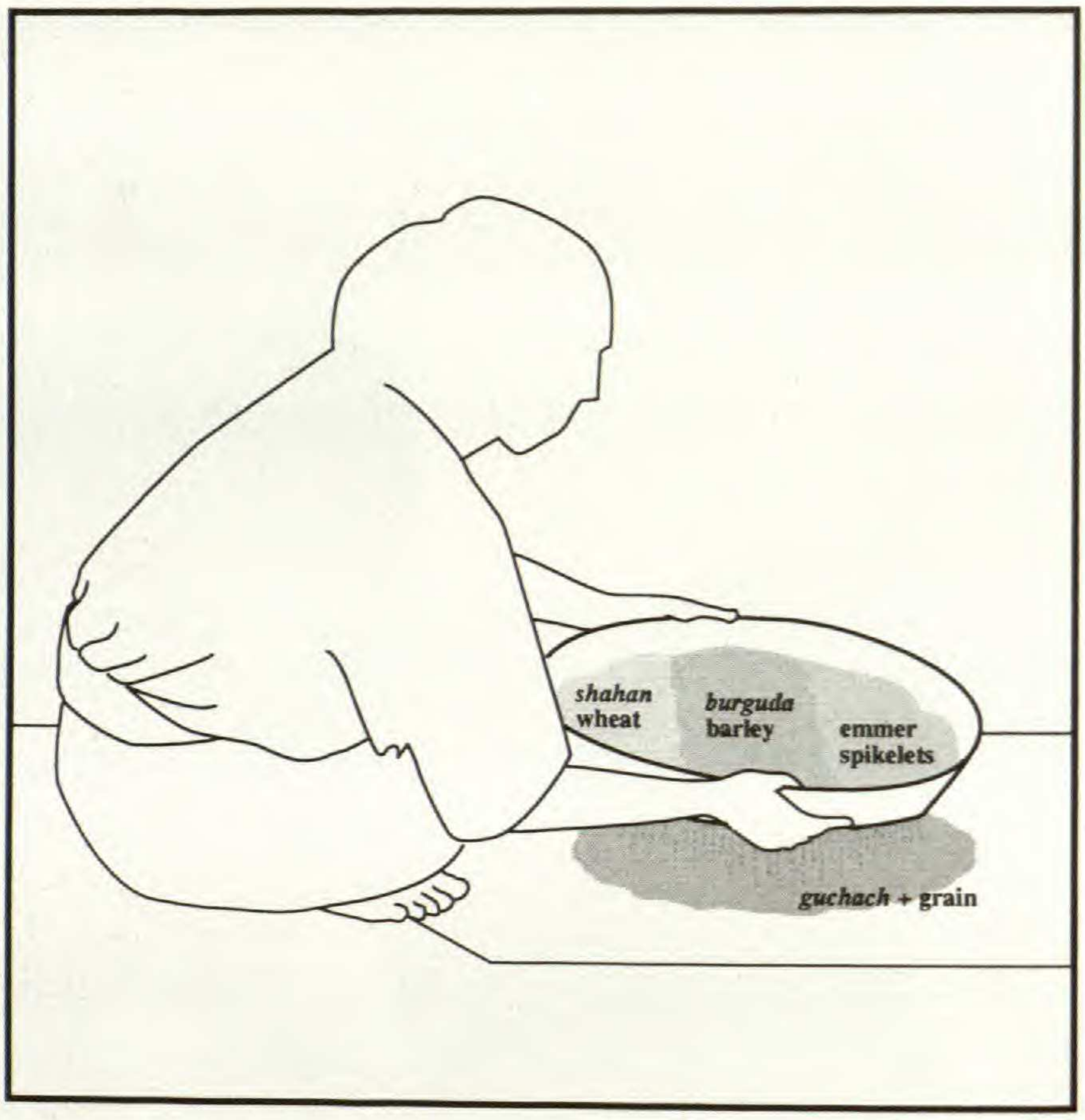


FIGURE 11.—Schematic drawing of a woman separating four components using the *mihehai* technique.

actions which further encourage the separation of components and removal of fine particles. This activity may or may not involve tossing materials from the *mihea* into other containers. ***Mihehai*** is sometimes accompanied by hand-sorting, which occurs if the harvest contains excessive amounts of impurities such as stones, soils, and large straw fragments. These elements are discarded on the compound floor. When the ***mihea*** is employed at this stage, four fractions are produced: 1) a ***guchach*** and grain mixture that falls through the sieve; and remaining on top and sequentially winnowed are separate accumulations of 2) spikelets, 3) ***burguda*** barley, and 4) ***shahan*** wheat grain. These last three components are gradually sorted out on the ***mihea*** through the circular and sideways movements of ***mihehai*** very skillfully executed by the winnower, after which they are tossed into separate containers. Figure 11 is a schematic drawing of ***mihehai*** at this stage, with the four fractions described in samples 2–5 of Table 3 and illustrated in Figure 12. The ***guchach*** and grain passing through is further processed using a ***mihea,*** but this sieving step is not usual. Because this particular harvest was relatively impoverished, many grains were small and easily broken so that a greater quantity than normal passed through the ***mihea.*** The ***guchach*** and grain mixture is sieved to produce two fractions: 1) ***guchach*** which falls through, and is used as fodder and 2) a ***shahan*** wheat and ***burguda*** barley mixture remaining on top which is hand-separated and combined with previously winnowed wheat and barley. The ***guchach*** can be further processed by drying, pounding, and winnowing to extract more grain, in situations of extreme food shortage.

FIGURE 12.—Four components separated using the ***mihehai*** technique, Wayzaro Yalemser Asbaha, Adi Hana. The ***mihea*** is partially visible at the top of the photograph, with ***guchach*** + grain detectable beneath. Emmer spikelets are in the basket to left, while the ***sefi*** in the foreground contains ***shahan*** wheat (top right) and ***burguda*** barley (bottom left). The diameter of the ***sefi*** is approximately 42 cm. Processing residue contents are described in samples 2–5 of Table 3.

As illustrated in sample 6 of Table 3, grains of wheat, barley and the weed *Avena sterilis* L. are the main components of ***guchach.***

Reports of poor harvests by informants are corroborated by the presence of large quantities of single-seeded emmer spikelets in residues collected during the processing episode summarized in Tables 2 and 3 (cf. Willcox 1999:487). A total of 53% (1521) of completely threshed spikelets (n = 2887) examined in this sample are single-seeded. In addition, 6% (181) of completely threshed spikelets display a barrel-type disarticulation pattern where the rachis segment adheres to the inner side of the spikelet. This is a pattern typically observed in spelt wheat (Zohary and Hopf 2000:30). The occurrence of this feature in emmer may be related to a combination of factors including threshing practices and depauperate plant populations (Laura Morrison, personal communication, 2000). Farmers attribute these unusual traits to water deficiencies and other ecological stresses experienced during the growing season.

Figure 4 illustrates the processing of spikelets extracted from the mixed crop and ***gurdie*** originating from the threshing floor. This ***gurdie*** does not normally undergo preliminary sorting for wheat and barley grains. Beginning with semi-clean spikelets, they are first sieved and winnowed using a ***mihea.*** This produces four fractions: 1) ***guchach*** falls through the sieve and is used as fodder; 2) a wheat and barley grain mixture remaining on the sieve, which is tossed and later hand-separated and added to the previous wheat and barley (Figure 3); 3) ***gurdie*** is tossed into a separate basket and processed later with other ***gurdie*** arriving from the threshing floor; and 4) spikelets are tossed into a different container and further processed by hand-sorting, the cleanings of which are discarded on the compound floor. At this point, spikelets are stored in the living quarters and processed in small amounts as needed. Large-scale processing and storage of clean emmer grain for household consumption is not practiced in this region.

When required, spikelets are sun-dried for up to two days and are never parched before pounding. None of the informants knew of anyone who parched or dried spikelets using an oven, and water is never added before pounding. The same applies to the processing of hulled barley. Pounding occurs in a wooden mortar (***mogu***) with a wooden, stone or metal pounder (Figure 5). When asked if a stone quern (***metahan***) is ever used to dehusk emmer, informants unanimously agreed that this never took place, and even though some farmers used mortars made of stone, wooden ones are preferred. Farmers maintain that using stone mortars results in too many broken grains, a problem that is avoided by the use of a wooden mortar. The action of pounding emmer spikelets in a ***mogu*** is very similar to that reported in an experimental study by Bower (1992:238). Free grains accumulate at the bottom of the mortar while chaff rises to the surface and is thrown clear by pestle movements. The category "empty glumes" in pounded samples 14 and 28 (Table 3) is dominated by heavy chaff elements (glume bases and spikelet forks): sample 14 produced 30% (n = 31) spikelet forks and 70% (n = 71) glume bases while sample 28 (***gurdie*** from threshing floor) consisted of 48% spikelet forks and 52% glume bases.

After pounding, the mixture is sieved and winnowed using a ***mihea***. This produces four fractions: 1) a ***kitkat, ebuk,*** and grain mixture which falls through the sieve; and remaining on top and tossed into separate baskets using the ***mihehai*** technique are 2) clean grain which is ready for grinding into flour (hand-sorted beforehand, if necessary), 3) ***ebuk*** which is tossed off the ***mihea*** and used as fodder or discarded, and 4) unhusked spikelets which are tossed into a separate basket, later sieved with a ***monfit*** or winnowed using a ***sefi*** if necessary (with cleanings discarded), and then reprocessed. It is at this point that the majority of heavy chaff elements are removed. ***Ebuk*** in samples 15 and 29 (Table 3, Figure 4) consists almost entirely of spikelet forks with glumes attached. Similarly, experiments involving pounding emmer in wooden mortars have revealed a relatively high occurrence of intact spikelet forks (Meurers-Balke and Lüning 1999:249).

The ***kitkat, ebuk,*** and grain mixture that falls through the ***mihea*** is winnowed using a ***sefi***. This produces three fractions: 1) ***ebuk*** which is tossed and used as fodder for chickens; and remaining on top and removed by hand are 2) clean grain and 3) ***kitkat*** which is broken grain that is especially good for making ***mahoyo*** soup or is mixed with other clean grain and ground into flour. The clean grain removed at this point (sample 21) frequently requires hand-sorting to remove fine particles. In contrast to the previous stage, the ***ebuk*** tossed from the ***sefi*** (sample 20) contains mainly of light chaff elements with fewer spikelet forks or glume bases attached.

This winnowing action on the ***sefi***, called ***mentertar***, is accompanied by ***mubukats***, a term which refers to the up and down motion of the ***sefi***, employed to toss materials while sorting or discarding. In ***mentertar*** several fractions are separated quite deftly. It involves shaking the ***sefi*** in a sideways and circular motion, an operation designed to sort materials and remove impurities. Elements are gradually separated into different components on the ***sefi*** and are sequentially tossed or scooped by hand into various containers. Implements resembling the ***sefi*** are used by Tuareg peoples in Ahaggar, where similar winnowing techniques are practiced (Gast and Adrian 1965:23–25, 31; Nicolaisen and Nicolaisen 1997:330). ***Mentertar*** seems comparable to "yandying" practiced by Australian aboriginal women of the Great Sandy Desert, northwestern Australia. Cane (1989:105–106) suggests that this technique is a substitute for winnowing and sieving. It is also similar to "winnowing by shaking" using a ***chaata*** as observed in Andra Pradesh by Reddy (1991:23; 1997:171–172), who also describes it as a replacement for fine sieving and an adaptation to processing smaller-grained cereals. Unlike the examples from Australia and India, ***mentertar*** does not appear to be a blanket replacement for fine sieving, but instead, it is employed in the latter stages of all household cereal processing to remove the last impurities. However, in the case of smaller-grained cereals such as tef and finger millet ***mentertar*** does appear to replace fine sieving, where it is preceded by coarse sieving (in the absence of ***mihehai***). Thus, emmer represents one of two cereal processing pathways observed in central Tigrai: one for larger-grained cereals (all wheats, barley, and sorghum) characterized by the use of ***mihehai*** followed by ***mentertar*** (without coarse sieving); and another for smaller-grained cereals (tef and finger millet) which are subjected to coarse sieving followed by ***mentertar*** (without ***mihehai***) (D'Andrea in prep.).

Gurdie brought from the threshing floor is processed independently. If ***shahan*** wheat or ***burguda*** barley grains are present they are removed by hand, but this is not usually necessary. This is because ***gurdie*** is gathered by raking on the threshing floor, an action that tends to miss loose grains of wheat and barley. ***Gurdie*** is first sieved and winnowed using a ***mihea,*** and this can be accompanied by the simultaneous removal of large straw pieces and stones by hand. Three fractions are produced: 1) ***guchach*** that falls through the sieve and is used as fodder; and remaining on top are 2) ***gulam*** which is tossed off the ***mihea*** and used as fodder for livestock, and 3) ***gurdie*** which remains on top and is collected by hand. It is then hand-sorted with cleanings discarded and stored in the living quarters. When required, stored ***gurdie*** is processed in small amounts in a manner similar to but separate from stored spikelets (Figure 4). Informants process ***gurdie*** separately because it contains more impurities. A comparison of equivalent residues produced during post-pounding processing of semi-clean spikelets versus ***gurdie*** in Table 3 (e.g., compare samples 13 and 27; 14 and 28; 15 and 29; 16 and 30; 17 and 32; 18 and 31), reveals that ***gurdie*** at all processing stages does tend to include more impurities.

In the recent past, grains were ground by hand using a stone saddle quern (***metahan***). Communal mills were introduced in the region in the early 1990s, and are now used by many families for milling grain. Several informants described the current methods employed in flour milling. After grinding at a communal mill,[9] emmer flour is sieved at least twice at home, first using a coarser sieve (***monfit tara***) which produces ***haser nifai*** and ***kitkat.*** These by-products are fed to chickens. Flour is sieved a second time, preferably using a finer sieve (***monfit shi'i***), but because this implement is relatively expensive, many women use the coarser sieve once again. Cleanings from this second sieving are normally discarded and rarely used in making ***sua.*** Informants in this region emphasized that emmer is never used in beer making, only finger millet, sorghum, and barley.

Whole emmer grain is consumed after roasting on a metal griddle to produce ***kollo*** or used in making a weaning food known as ***mahoyo*** (or ***tuto***). The ***kollo*** making process is described in detail elsewhere (Lyons and D'Andrea in prep.). Farmers agree that of all available cereals emmer makes the best quality ***kollo*** because the grains are "very tender" and have a "sweeter" taste. To demonstrate this, informants encouraged the authors to taste ***kollo*** made from ***shahan*** wheat and emmer, both of which were roasted on a metal griddle in the traditional manner. It was immediately apparent to us that emmer ***kollo*** is far superior in taste and is less gritty than ***kollo*** made from ***shahan*** wheat. The delicate texture of emmer ***kollo*** may be related to thinner pericarps present in hulled wheats (Le Clerc et al. 1918:216; Nesbitt and Samuel 1996:43). In preparing ***mahoyo,*** whole grain is soaked, boiled, and forced through a fine metal sieve (formerly made of basketry). Processed ***kitkat*** is well suited to this purpose because it consists of already broken grain. The strained mass is boiled and fenugreek (*Trigonella foenum-graecum* L.), honey, and milk are added.

Emmer flour is used in making leavened and unleavened staple breads, mainly ***embasha, kicha,*** and ***taita. Embasha*** made at Easter is traditionally made from emmer flour. When making ***taita,*** emmer flour is never used on its own, but mixed with barley flour at a ratio of 2:1 (barley:emmer) or with sorghum at a ratio of 1:1. The flour also is used to make a soup called ***mouk.*** Emmer flour is considered the best to make ***ga'at*** porridge, which is eaten mainly by invalids, nursing mothers (Edwards 1991:53), sick people, and children, because emmer is considered to be more easily digested than other wheats. Informants generally describe emmer as a cereal with special properties and medicinal value. Others report that broken bones heal more quickly with a diet of emmer porridge (Tesfaye and Getachew 1991:51).

DISCUSSION

The Tigrayan peoples consulted in this study continue to cultivate emmer as part of a living tradition despite the accessibility of naked wheats. Production is at the household level, and as such, the information produced herein is complementary to that provided by Hillman (1984b), who examined larger-scale communal bulk processing in Turkish villages. Moreover, the Tigrayan evidence has revealed aspects relating to household production that are not otherwise preserved in ancient texts (Murray 2000; Samuel 1993) or as archaeobotanical remains (Hillman 1984a; Jones 1981), and are not directly measurable in controlled experiments (Meurers-Balke and Lüning 1999; Samuel 1993). In particular, it draws attention to a largely overlooked aspect of women's lives in rural communities, namely, the burdensome task of dehusking and subsequent cleaning of hulled or intercropped cereals once they are brought to the household from the threshing floor. As such, it is clear that the bulk of labor necessary in non-mechanized post-harvest processing of emmer rests with women.

In the household setting, emmer is considered among the most labor-intensive cereals to process, and this is often cited as a reason for the gradual disappearance of this crop. One is immediately impressed by the high degree of skill exhibited by women who are able to separate as many as four different elements using a *mihea* simultaneously as a sieve and winnowing tray. These processing techniques, and the time women spend in grain cleaning activities have been passed over in agronomic and ethnographic research (for exceptions, see Cane 1989; Gast and Adrian 1965; Tewolde 1993), even in investigations that purport to examine traditional methods (e.g., Asiedu 1989; Bencini 1991; Redhead 1989). These latter studies are more explicitly concerned with storage and milling performance of cereals for the purpose of improvement. Often, these descriptions end with threshing and the sequence is picked up again with food preparation with mention made of milling or general cleaning, ignoring the complexity and time consuming nature of these activities (e.g., Holm 1956:12).

It has been demonstrated that the recent introduction of the communal mill has resulted in a marked improvement of women's lives in rural Ethiopia (Tewolde 1993:224–225). However, the separation of grain from hulls, necessary in processing emmer, hulled barley, sorghum, and finger millet, continues to claim a substantial amount of time. The onerous nature of these tasks is further compounded by the operations necessary in hand-separating intercropped grains. When one considers the additional burden of grinding grain into flour, as well as other household tasks such as fetching water and fuel, it has been suggested that rural Ethiopian women had barely enough time to sleep (Tewolde 1993:222–232). Tigrayan informants report that hand-sorting and grinding on a saddle quern took up as many as 10–12 hours per day on alternate days. With the introduction of the communal mill, processing and hand-sorting of intercropped cereals now occupy an estimated 4–5 hours on alternate days. Women have dealt with these obligations by relying on shared labor groups, termed "Mutual Support Networks" (MSNs). These organizations are based on family ties or residential proximity and are means by which women help each other in times of high workload, including life-cycle celebrations and bulk food processing (Dessalegn 1991:31–38). Support networks are developed to varying degrees in different parts of Ethiopia, although milling and hand-sorting of intercropped cereals now have a rather diminished role in MSNs in the study area. The introduction of the mill has made it possible for women to participate in Food-for-Work programs during seasons of failed harvests. It has also allowed them time to make baskets and other handicrafts for sale in local markets, a pursuit which has contributed to the transition of Tigrayan villagers to a modern cash-based economy. Interestingly, since the introduction of communal mills, the overseeing of flour milling has shifted from the domain of women to that of men (Tewolde 1993:232).

Many of the elder Tigrayan women we interviewed are of two minds concerning the discontinuation of labor-intensive activities such as emmer processing and milling flour on the saddle quern. They certainly do not miss the hard work, but they do lament the loss of socializing that is an important aspect of these work support groups. As such, the introduction of communal mills by the Tigrayan government is beginning to set in motion a social impact illustrative of the trend of individualization where actions and decision making by individuals gradually become independent of community ties, resulting in increased autonomy of households (Counihan 1999:35). This phenomenon has been examined specifically in a context of bread making in an anthropological study carried out in Sardinia. In this region, villages scattered in a rugged mountainous landscape remained isolated from early twentieth-century economic developments taking place elsewhere in Italy. Traditionally, bread was considered the most significant food in Sardinian cuisine and women assisted each other in the long process of baking in the home. These activities brought family, friends, and neighbors together during which they gossiped about their lives and village issues, thereby reaffirming local cultural norms. Following the First World War, bread baking in the home steadily declined and ultimately disappeared for various reasons, including the establishment of public bakeries, closure of grain mills, and introduction of mass-produced breads. The use of public bakeries was initially resisted, but eventually bread baking and other home-based food processing activities ceased, along with the concomitant social interaction. In a manner analogous to communal mills in Tigrai, bread baking in Sardinia has shifted from the purview of women to that of men who operate the bakeries, and in so doing, social relations in the community are irreversibly transformed (Counihan 1999:32–35).

Despite the shared labor practices observed in the field and recounted by informants, most households in the study area possess a complete set of equipment to produce breads and all other foods, including grinding stones, ovens, and mortars (D'Andrea et al. 1999:114–116), or at least they did so in the recent past (for a contrasting archaeological example, see Samuel 1999:133–141). Apart from times of food shortages, rural households typically aim to meet all food consumption requirements with few culinary items purchased from regional markets (Tewolde 1993:190). Unfortunately, there are no archaeological investigations available on rural domestic architecture in Ethiopia, although it is clear that emmer has been cultivated there since pre-Aksumite times (Boardman 1999:143; Phillipson 2000:469), and reached such prominence as to be illustrated on Aksumite coinage (Phillipson 1993:354–355). Given the Tigrayan ethnoarchaeological data on labor requirements in the household processing of intercropped and hulled cereals such as emmer, we may speculate that in the absence of state-supplied rations or food exchange networks, shared female labor in cereal processing must have been a fundamental necessity of rural life, certainly in recent times, and perhaps in the more distant past. Studies of Aksumite and later inscriptions indicate that in addition to meeting normal family food consumption requirements, rural peoples were obliged to supply goods to kings and local officials in the form of tribute or tax. In Aksumite times, this payment was a condition of land tenure among conquered populations. A remnant of this practice persisted into the Middle Ages and recent times in the form of ***dergo***. Rural inhabitants were obliged to offer ***dergo*** to the monarch, troops, and ambassadors travelling through subjugated lands, as well as to local officials. It consisted of prepared food, such as ***taita***, wheaten bread, flour, oil, sauces, drinks, small game and other comestibles, and occasionally clothing, currency and pack animals. In some cases, the demand for goods could be very great, particularly when required by military expeditions (Kobishchanov 1979:161–166). Providing tribute in the form of bread and flour, as opposed to grain, would have had a significant impact on the workload of rural women, in which case communal labor networks would have been critical.

In marked contrast to household processing, emmer is widely considered among the least demanding cereals to thresh, as normally only one threshing is required to adequately break down a harvest into spikelets. The field threshing of emmer described here differs in some respects from that reported by Hillman (1984b) and from studies of ancient Egyptian reliefs (Murray 2000:524–526). These latter investigations have documented the occurrence of coarse sieving on the threshing floor, where the sieve retains impurities, allowing grains and weed seeds to pass through for further processing (Jones 1984:45). As stated earlier, Tigrayan informants insist that emmer is never sieved in this manner during threshing and coarse sieving is only performed during the processing of tef and finger millet (D'Andrea in prep.). Hand-winnowing on the threshing floor (Figure 8) has no apparent analogue in the available literature on glume wheat processing. In Tigrai it is consistently used as a replacement for the winnowing shovel. It clearly represents a technique used in processing small quantities of all cereals, and as such, may not be expected to occur in communal processing (Hillman 1984b) or be described in ancient sources (Murray 2000). Another interesting feature of threshing in Tigrai is the ubiquitous use of the ***mihea*** in basket-winnowing (Figure 9). While baskets or sieves have been mentioned as alternative winnowing tools employed on threshing floors in Turkey (Hillman 1984b:124) and in ancient Egypt (Murray 2000:525), the ***mihea*** is regularly used in Tigrai as the last winnowing implement in the field processing of all cereals, regardless of grain size. A comparable method has been observed in rural regions of southern India near Madurai, where a funnel-shaped container with no apertures is used after threshing (Richard Shutler Jr., personal communication, 2001). A similar basket-winnowing technique, referred to as "wind-winnowing," is documented in Andra Pradesh by Reddy (1991:23, 25, 1997:170). The Tuareg also employ a basket-winnowing technique in processing cereals on the threshing floor (Nicolaisen and Nicolaisen 1997:274). One could speculate that these basket-winnowing techniques reflect an adaptation to processing millets and similar smaller-seeded cereals, in much the same way as ***mentertar*** is well suited to the household processing of tef and finger millet. Unlike the Near East and Europe, the cultivation of millets and small-grained cereals are major components of agricultural systems in tropical regions of Africa and South Asia. In many ways, Tigrayan practice appears to represent an amalgamation of Near Eastern and tropical African/South Asian crop processing traditions (D'Andrea in prep.).

Although small sample sizes preclude the possibility of quantitatively characterizing processing residues, several patterns observed at different stages suggest that such approaches may be possible in future studies. Comments on residue composition have been made in previous sections, and these could be tested with larger and more consistent sample sizes. In addition, informants clearly differentiate fodder types, and local terminology used in all cases is consistent, including ***ebuk*** (mainly empty glumes with heavy chaff elements) which is fed to chickens, ***guchach*** (mostly grains of barley and *Avena sterilis*) for donkeys and other livestock, and ***gulam*** (a mixture of several impurities with no dominants) fed to livestock. The storage of these fodders has some potential to be visible archaeologically. These elements along with ***gurdie*** and spikelets from the threshing floor are stored inside main residential buildings while straw from the threshing floor is kept in a fenced courtyard adjacent to buildings (D'Andrea et al. 1999:114–115). Fodders are not normally subjected to processing in addition to that described above, except for extra hand-sorting to remove grains of *Lolium temulentum* L. (***kurdad***). Farmers indicated that these seeds are toxic and produce hallucinogenic effects if grazed by cattle or if ground into flour and consumed by humans in breads. This effect is produced by a fungal infestation (ergot), common in seeds of *L. temulentum,* which has a narcotic effect on humans and livestock (Phillips 1995:18).

Our fieldwork has addressed several questions relating to processing technology and storage of emmer in households, information which has relevance to archaeobotanical interpretations of ancient processing. Emmer dehusking methods have been a major concern of archaeobotanists and agricultural historians, where the role of stone querns versus wooden mortars is at issue. Although dehusking can be accomplished by rotary querns (Beranová 1989:322–323; Nesbitt et al. 1996:236), this technology, which developed in Roman times (Moritz 1979: 9), does not seem to have diffused to Ethiopia. Classical sources such as Pliny indicate that wooden mortars are the instrument of choice in emmer dehusking because they are less damaging to the grain (Pliny xviii, 112; Moritz 1979:22–28). Meurers-Balke and Lüning (1999:244) conclude that although stone saddle querns can be used to dehusk emmer, especially if spikelets are heated to low temperatures, the number of cracked grains produced is exceedingly high. They also find that wooden mortars, in particular a solid mortar made out of a tree trunk (identical to the ***mogu***), is a more effective instrument of pounding (Meurers-Balke and Lüning 1999:241–249). Similar conclusions have been reached by other workers (Harlan 1967:199; Hillman 1984b:130). Vavilov (1931:8–9, Figures 2 and 3) maintains that the normal way of dehusking emmer in Ethiopia is through the use of a tall wooden mortar and a wooden pestle, while grinding grain into flour is accomplished using a stone quern. Such observations are consistent with our ethnoarchaeological study. According to informants, grinding stones are never used to dehusk emmer, because they cause excessive damage to grains. Dehusking invariably occurs in a wooden mortar where the hand-held implement is either metal or wood. In Tigrai, grinding stones are used mainly in milling flour and to remove hulls in grass pea (*Lathyrus sativus* L.) processing (Butler et al. 1999: 129). Distinctly smaller grinding stones are used to pulverize various spices used as flavorings.

Pre-treatment of emmer prior to pounding by parching/drying (Nesbitt and Samuel 1996:46) or wetting also has been widely discussed, both of which are described by Pliny (xvii, 7–8, 97–98). Another Classical writer, Varro (1.63), mentions the parching of spikelets. Parching prior to pounding has been described for rural Turkey (Hillman 1984b:129). Nesbitt and Samuel (1996:43–46) point out, however, that heating may have had other purposes, such as drying an unripe harvest. Meurers-Balke and Lüning (1999:252) conclude that parching is unnecessary in dehusking emmer while Harlan (1967:199) finds that roasting does not appreciably improve pounding: comparable results are achieved by pounding unheated spikelets for a longer period of time. These latter observations are echoed by Adi Hana and Mai Kayeh informants. In this region, parching is never used, but spikelets are dried in the sun for as long as two days prior to pounding. Sun drying is believed to make pounding more effective. In contrast to experiments where moistened spikelets are pounded effectively in shallow mortars (Hillman 1984b:135–136; Nesbitt and Samuel 1996:52; Samuel 1993:280, 2000:560), water does not appear to be necessary when tall wooden mortars are used (Harlan 1967:199; Nesbitt and Samuel 1996:53). Adi Hana and Mai Kayeh informants maintain that spikelets are never moistened when pounded in a wooden mortar. This has resulted in a sequence of processing steps that differ from the processing model developed by Samuel (2000:541) based on several lines of evidence from ancient Egypt. In the Egyptian model, the wetting of spikelets requires a post-pounding drying stage, while drying in Tigrai precedes pounding.

Glume wheat storage practices have been of interest to archaeobotanists. Hillman (1984a, 1984b) suggests that storage in more arid regions of Turkey would have been in grain form, while storage as spikelets was characteristic of areas experiencing wet summers. Although not directly observed by Hillman (1984a: 9), he suggests that in small farmsteads where large processing equipment is not available, storage in spikelet form would be expected to occur. This latter method was commonly used in ancient Egypt (Nesbitt and Samuel 1996:51–52; Samuel 1993:278). The conclusion that glume wheats are best stored as spikelets is supported by several workers (Meurers-Balke and Lüning 1999:241; Murray 2000:527–528) and by Classical writers (Varro 1.63, 1.69). In Adi Hana and May Kayeh emmer storage is always in spikelet form and additional processing is completed in small quantities as required. An exception is when relatively larger quantities are dehusked in preparation for selling at local markets. In this case bulk storage is in grain form (cf. Hillman 1984b:126). Meurers-Balke and Lüning (1999:250) state that as long as stored glume wheats are dried before storage, another drying period immediately before dehusking is not necessary. This may be the case, however, Mai Kayeh and Adi Hana informants always sun dry spikelets before dehusking. The idea that smaller mortars are used in cases when spikelets are stored in households and processed as needed while much larger mortars are used in bulk processing (Hillman 1984b:130) finds support in this study, as ***mogu*** internal diameters average around 20 cm. In a manner analogous to grinding stones (mentioned above), even smaller wooden mortars are used in the study area for processing spices.

The issue of flour sieving is discussed by Samuel (1993:281–282), who concludes through experimentation that emmer flour produced on a saddle quern is sufficiently fine as to not require sieving, despite the fact that this activity is depicted in Egyptian reliefs. Although Tigrayan informants report that communal mills have introduced more impurities to all flours thereby creating the need for several sievings, they unanimously agree that all flours except tef[10] must be sieved even when milled by stone querns. They do recognize, however, that emmer produces fewer impurities when milled on a saddle quern A similar observation is made by Le Clerc et al. (1918:216) who, based on milling experiments, conclude that emmer and Polish wheat (both tetraploids) produce significantly smaller quantities of bran when milled.

CONCLUSION

Although Ethiopia is well known as a remarkable reservoir of agrobiodiversity, genetic resources have been eroding because of civil unrest, poverty, land shortages, environmental degradation, and the replacement of indigenous land races with introduced cultivars (Edwards 1991; Engels and Hawkes 1991; Melaku 1991). The decline in emmer cultivation is clearly part of this overall pattern. Despite these regrettable circumstances and the high processing costs for women in the household, emmer cultivation has persisted in Tigrai, apparently because foods produced from this cereal are highly appreciated. This ethnoarchaeological study of household emmer processing has revealed several technological and social aspects relating to this disappearing crop. It has outlined field winnowing practices that differ from those observed in the Near East and Europe, which may indicate a tropical African and/or South Asian influence in agricultural technology. Several conclusions relating to emmer processing based on experimental replications (Meurers-Balke and Lüning 1999; Samuel 1993) find general agreement in this study, in particular, dehusking, storage, and other processing issues, all of which are relevant to the interpretation of the archaeobotanical record. Finally, although the working conditions of women in Tigrai have certainly improved with the introduction of communal mills, the onerous tasks of pounding, cleaning, and separating intercropped and hulled cereals remain a reality of life. As a result, rural support networks in existence before the establishment of communal mills, although somewhat diminished, still operate with some regularity today. Given the constraints imposed by the nature of these cereals, it is possible that shared female labor in cereal processing was a widespread phenomenon of Tigrayan village life in the recent past, and in all probability, in ancient times as well.

NOTES

[1] The terms "hulled" or "glume wheat" include several species and ploidy levels of *Triticum* such as emmer, einkorn (*Triticum monococcum* L.) and spelt (*T. aestivum* ssp. *spelta* (L.) Thell.). The ears of these wheats break down into spikelets after threshing, and additional processing involving pounding is required to release grain from enclosing hulls. The ears of "naked" or "free-threshing wheats," such as durum (*T. turgidum* conv. *durum* (Desf.) MacKey) and bread wheat (*T. aestivum* ssp. *vulgare* (Vill) MacKey), have grains that are released during threshing and do not require pounding (Zohary and Hopf 2000:33–53).

[2] Spikelets are segments of ears made up of grain that is tightly surrounded by light (glumes) and heavy (spikelet forks, glume bases, rachis segments) chaff components (see Charles (1984) for a description). Emmer spikelets are typically two-grained, but single- and triple-grained forms are also known to occur (Percival 1921:191).

[3] Tigrinya names are included where available. However, there is considerable variation in English transliteration of Tigrinya terms, and those presented here are close approximations.

[4] All informants named in this study have given permission to be so identified.

[5] Tetraploid wheats (genomic designation AABB or AAGG) have a chromosome number of $2n = 28$, and include hulled forms such as emmer, and free-threshing types such as durum and Polish wheat (*T. turgidum* conv. *polonicum* (L.) MacKey) (Zohary and Hopf 2000:28).

[6] Hexaploid wheats (AABBDD) have a chromosome complement of $2n = 42$, and include free-threshing types such as bread wheat and hulled forms such as spelt (Zohary and Hopf 2000:28).

[7] In Tables 2 and 3, "wheat" refers to bread wheat, and remains of crops are listed as common names. Crops not mentioned in the text are lentil (*Lens culinaris* Medik.), chickpea (*Cicer arietinum* L.), and flax (*Linum usitatissimum* L.). These and other crop contaminants were introduced in the field or on the threshing floor.

[8] Hand-sorting refers to removal of impurities, while hand-separation implies the separation of products, especially of grains in mixed harvests.

[9] The following information on food preparation was described by informants and not directly observed.

[10] Although sieving tef flour that has been milled on a saddle quern is considered unnecessary, Tigrayan informants recall that they used to sieve it regardless, to be certain that all impurities are removed.

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